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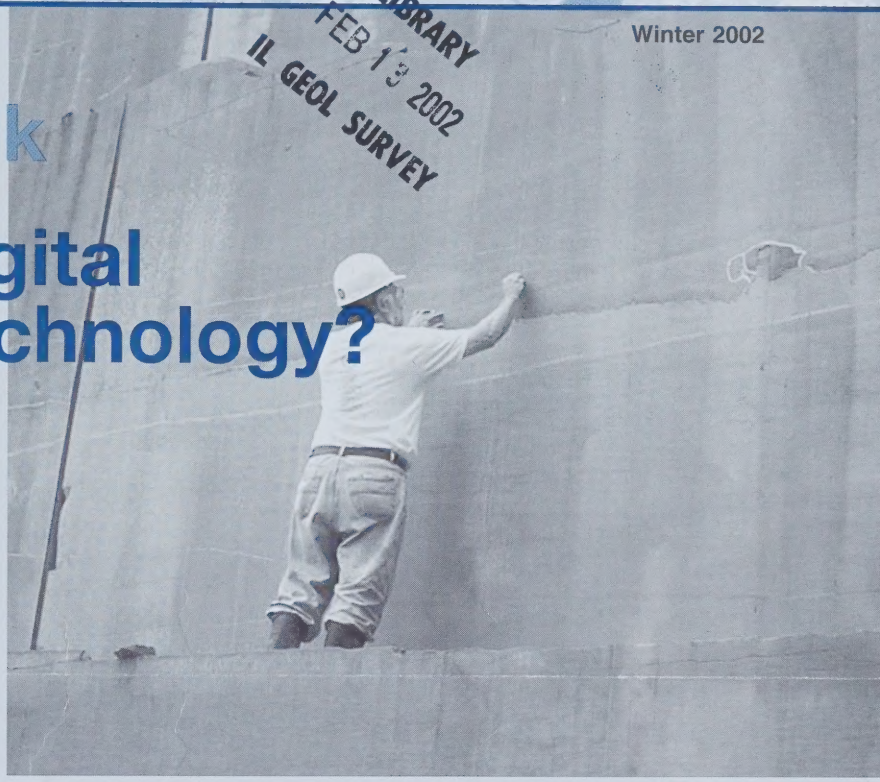
Sidewalk Chalk and Digital Technology?



By Leslie Drozen

The Maple Hill Quarry, located approximately four miles southwest of Bloomington, has been an active limestone quarry for close to 100 years. For the past 15 years, however, IGS researchers Todd Thompson and Brian Keith have been studying the limestone exposed by quarrying. Now Thompson and Keith have completed their first quarry mapping project using digital techniques they have developed.

"We are the only ones doing this, as far as we know," Keith said.

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Ground Penetrating Radar

By Leslie Drozen

Ground Penetrating Radar (GPR) techniques have been around since the 1980s, but until the early 1990s, when companies started marketing GPR technology packages, the equipment used was cumbersome and difficult to operate. "You had to be part geophysicist and part electrical engineer to use the thing," Survey researcher Todd Thompson said.

The Indiana University Department of Geological Sciences has graciously been allowing Survey researchers to use their older GPR system, but in July the IGS purchased the Noggin 250 GPR SmartCart, which is more user-friendly.

Ground Penetrating Radar is a shallow seismic geophysical method used to determine if there are changes in the host

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IGS geologist Todd Thompson uses the GPR SmartCart at the Maple Hill Quarry, near Bloomington.

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From the State Geologist

This year, the Indiana Geological Survey will be hosting the annual meeting of the Association of American State Geologists (AASG). The membership of the AASG consists of the heads of the geological surveys in each of the 50 states and Puerto Rico. I have chosen historic New Harmony for the meeting place because of the role that town played in the development of geology in early nineteenth century United States. It was there that David Dale Owen established his famed laboratory and mounted numerous expeditions to explore the geology of the then young state of Indiana and the Northwest Territories.

The meeting will convene in the recently rebuilt Rapp Granary/David Dale Owen Laboratory. While the resort-like setting of the New Harmony Inn will house the attendees, the meeting is anything but leisurely. For three days, state geologists, their associates, and AASG honorary (retired) members will conduct business and hear from the numerous federal agency officials who are invited to give presentations. Of particular value to me are the breakout sessions, where lessons learned at other state surveys are shared with colleagues. These topics range from keeping current in information technology (on a state budget) to what kinds of survey publications sell best. Not surprisingly, this has proven to be a particularly popular part of the meeting.

There is time, of course, for attendees to participate in field trips, which also serve the purpose as a backdrop to renew important relationships. This year, we will be leading trips to a large aggregate quarry, a surface coal mine, and the limestone district of Lawrence and Monroe Counties.

We're excited about the prospect of playing host to about 150 visitors, including state geologists, their spouses and families, and various public officials and dignitaries. We only get this chance to show off Indiana once every 50 years or so, and we're not going to disappoint anyone!

John Steinmetz

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IGS 2002 Calendar

Since when has Indiana had mountains? That's what some people say when they first see the IGS 2002 wall calendar! The calendar features a three-dimensional map of the state of Indiana, but in order to reveal features of the landscape that are otherwise too subtle to be seen, this map greatly exaggerates topographic relief. Now we see the sinuous ridges created by the advance and retreat of glaciers in the northern part of the state and the more rugged topography of southern Indiana, the result of long erosion cycles, as well as other features.

The map was derived from digital elevation models from the National Elevation Dataset of the U.S. Geological Survey, and was created by Indiana Geological Survey glacial geologists and graphics personnel.

The 16" x 26" calendar is printed in full color on heavy poster paper, and is available from the IGS at our publication sales office for $1.00, or by mail for $3.75, including shipping.

Order now! Call 812-855-7636 or send an e-mail message to IGSinfo@indiana.edu. The calendar will be mailed in a crush-proof mailing tube.

Ground Penetrating Radar

(continued from page 1)

rock or material being measured. To do this, it sends radio waves into the ground. The waves go through different materials at different speeds and reflect off objects in the ground, such as pipes, to give researchers an idea of where rock layers, particularly sedimentary, change underground, where man-made objects are, and it can even detect where the soil has been changed in some way. Ground Penetrating Radar can be corrected for small changes in topography, but it works best in flat regions.

"However," Survey researcher John Johnston warns, "because it is a geophysical method it doesn't tell scientists everything about the area under observation.

Ground Penetrating Radar has several advantages over other research methods. Primarily it is noninvasive, so it can be used in state and national parks without disrupting habitat, and landowners can determine what is under their property with minimal digging and tearing up of their land.

The SmartCart has several advantages over older systems. For one, it has a running odometer which can be set so the radar will trigger regularly after a certain distance. This makes it easier for scientists to record where and how often they are taking readings. With older systems, scientists used a tape measure to record the distances.

Second, it has a Digital Video Logger (DVL) screen that shows the data results as they are being measured. The DVL, which is similar to a computer screen, can easily be hooked up to a computer via a transfer cable, so the data can be manipulated and analyzed. Older systems require a laptop computer, which often crashes during use and is not as weather- or wear-resistant, and require more processing to transfer the data to a larger computer or network system.

Finally, the components of the SmartCart itself are more compact and simplified, as well as weatherproof, making data collection simpler and quicker.

The SmartCart is easier to use and "lets us collect many more GPR lines," Thompson said. "It allows me to understand the three-dimensional architecture so much more than I can with the few cores I usually have," he added.

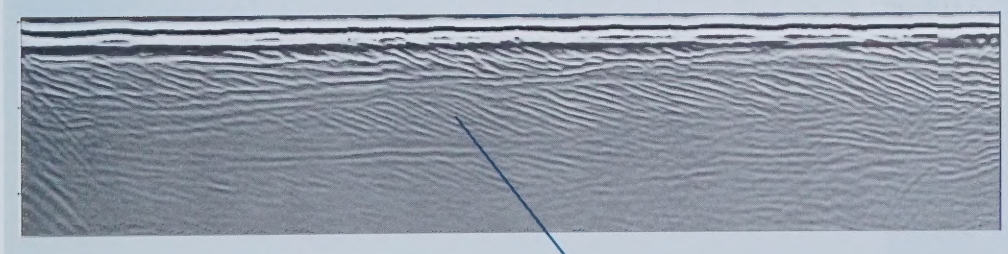
"All geologists dream of ways to 'see' under the ground," IGS researcher Nelson Shaffer, who has been using GPR to investigate karst features, said. "GPR helps us to do this and so is very attractive," he added.

The SmartCart comes with a 250 megahertz (Mhz) antenna, which means it sends out 250 million wavelengths per second. Each wavelength is 1.2 meters long and can penetrate 1 to 15 meters in ideal conditions, with a resolution of 30 centimeters. Therefore, researchers can detect changes in the sediment up to 15 meters (approximately 45 feet) deep and be accurate to within a range of approximately 30 centimeters.

The best part about the SmartCart, according to Johnston, is that it can be used by different departments for a variety of projects. "It can be used by so many disciplines, not only by just one researcher," he said. So far, the IGS SmartCart has been used by sedimentologists for shoreline research in the Great Lakes, by archeologists to find burial sites, and by hydrologists to identify features in areas of karst.

"The capabilities of this system are incredibly vast and we have only scratched the surface so far," Johnston said. ♦

This is a GPR log profile of cross beds in the Salem Limestone. The heavy lines at the top are "noise" from the radar waves reflecting off the ground surface.



Foresets show the incremental migration of individual dunes in an ancient carbonate shoal. (Interestingly, this log was taken in Maple Hill Quarry, also featured in the "sidewalk chalk" article on pg. 1.)

IGS Promotes Education in the Earth Sciences

The IGS demonstrated its GIS prowess during November 14—"GIS Day"—and displayed information to university students and the public at both IU's Geography Library and the Rotunda of the Capitol Building in Indianapolis.

The recipient of the 2001 IGS Director's Research Assistantship, Sarah Pietraszek-Mattner, worked this year in collaboration with John Rupp on a project investigating how hydrocarbon seeps degrade at or near the earth's surface.

Erik Kvale, IGS geologist, works with high school volunteer Nick Hill to construct a flume that will be used to demonstrate and study the formation of wind-formed sand ripples. Demonstrations will take place in various educational settings, such as the Wonderlab in Bloomington and the Indiana State Museum in Indianapolis.

IGS photographer Barbara Hill explains the map-making process to a group of home-schooled students. Many student groups tour the Survey to get a first-hand look at what earth scientists do.

And the AAPG Award Goes to...

Kevin Leineweber, a high school earth science teacher at McCutcheon High School in Lafayette, won this year's American Association of Petroleum Geologists (AAPG) Award for Excellence in the Teaching of Natural Resources in the Earth Sciences. Leineweber is a 1991 graduate of the Indiana University School of Education and has been teaching for eight years.

The award is given every year to a K-12 teacher who has been teaching for at least three years and who conducts at least one unit on natural resources per year. Leineweber submitted a unit he had taught on mineral use and extraction and on energy production.

The award includes $2,500 to McCutcheon High School for Leineweber's use and $2,500 for his personal use. In addition, Leineweber will receive an expense-paid trip to the AAPG Annual Meeting, to be held in January in Houston.

Sidewalk Chalk and Digital Technology

(continued from page 1)

A working limestone quarry offers a unique opportunity for geologists interested in studying the geology exposed by the cutting action of the quarry saws; having access to these exposures can allow researchers to better understand depositional patterns. However, the quarrying moves forward at a much faster pace than scientific research! The intriguing feature exposed today may be quarried out and on its way to being made into a building by next week.

Sawing, such as is done at area limestone quarries, "gives us a level of detail that we can study," Keith said. This type of data preservation is not possible at blasting mines, such as granite quarries, because of the fragments that are created in the explosion. "We really have a unique opportunity to study these bedding processes and structures," Keith said.

Early researchers measured vertical sections to understand quarry geology. But with the introduction of belt saws to the quarry industry, they found that quarry architecture was much more complicated; three-dimensional mapping was needed. Scientists took black and white photos of the exposed faces, and taped the photos together to create a mosaic view of the quarry. They then created a mylar overlay to mark important depositional features.

With their new method, these IGS geologists use colored sidewalk chalk to mark lines over the depositional layers directly on the exposed quarry face, and then take a suite of digital photographs of the face. Over the summer, when quarrying proceeds at a rapid pace, geologists are at the quarry every two weeks, sometimes more often, to take photographs of newly exposed faces. Then using specialized software, they edge-match the photos to create a seamless panoramic view of the quarry faces. The chalk lines in the photos are then traced digitally, creating a permanent digital record of the exposed face. This now can be used to build a three-dimensional model showing the periods of depositional structures and other natural features of the limestone.

Structural features change in three dimensions, Thompson explained, and "we wanted to come up with a way to demonstrate that." The polished walls in the quarry show the limestone's complexities and its heterogeneity.

"We are trying to reconstruct what that carbonate shoal looked like 335 million years ago," Thompson explained. "We're trying to understand the architecture of an ancient carbonate shoal and understand some little piece of time," he added. Understanding the architecture and how the sedimentary bodies are stacked together is valuable not only from an academic standpoint, but also aids in understanding how fluids, such as water and petroleum, flow through the area.

Crude oil is sometimes found in Salem Limestone, and so the information may also be applied to model more efficient extraction of this energy resource from underground reservoirs. Thompson and Keith cored plugs from the quarry to analyze their porosity and permeability. Porosity is the percentage of a stone that contains holes and can, therefore, hold a liquid such as oil. Permeability studies determine how connected those holes are, and how easy would it be for oil to move through that rock and collect in a reservoir.

This IGS research can be extremely useful to the stone industry. Currently, workers quarry until they get to stone that is not usable from an economic standpoint.

The information gathered from this project shows where stylolites and fracture orientations, both zones of weakness, exist. Stones having these features cannot be used as building material. After the researchers predict that stylolites and fractures follow certain depositional patterns and identify where these occur, quarry workers can cut along those zones of weakness, thereby wasting less rock.

Beginning in spring 2002, Thompson and Keith, along with geology graduate students from Indiana University, will be using the digital photography technique to map the depositional layers seen in the underground Eureka Quarry, 5 miles west of Bedford. To work safely in that underground quarry, cutters leave 20-foot-high pillars and walls to support the ceiling of the mine. Using lights, ladders, and other equipment that will enable them to work underground, geologists will map the depositional layers of that quarry.

The information gathered through mapping is now only applicable to Salem limestone, the most common limestone in Indiana, but we may soon find that it is relevant to other limestones as well. "We're just getting started on understanding the significance of the differences between quarries and regions," Keith said. ♦

Contacting the Survey

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New IGS Publications

IBS 5. ***Toward a More Uniform Stratigraphic Nomenclature for Rock Units (Formations and Groups) of the Pennsylvanian System in the Illinois Basin.*** **2001. By Tri-State Committee on Correlation of the Pennsylvanian System in the Illinois Basin.**
28 p., 9 figs., 1 plate.....Call for price

Geologists from the Illinois, Indiana, and Kentucky Geological Surveys have proposed revisions to Pennsylvanian nomenclature that further standardize names throughout the Illinois Basin; this standardization will improve communications among geologists and the coal mining industry working in the Pennsylvanian system, which encompasses three states.

OP66. ***Physical Testing Data for Indiana Limestone and Other Building Stone Materials: A Computer Database.*** **2001. By J.R. Hill, W.A. Hasenmueller, and S.S. Frushour.**
15 p., 1 fig., 4 tables ..... $35.00 includes booklet and CD-ROM

This digital offering is an important new resource for the limestone industry. The computer database includes data from over 40 years of physical testing on Indiana Limestone and other building materials in various popular database formats.

SR61. ***Physiographic Divisions of Indiana.*** **2001. By H.H. Gray.**
15 p., 2 figs. ..... $9.00 includes report and separate 23" x 30" color map plate

Physiographic Divisions of Indiana is an indispensable resource to those interested in Indiana's natural history. The report outlines topographic regions of the state and the geologic processes that formed these different landscapes. Included with the text is a full-color 23" x 30" map illustrating the four regions and their subdivisions.

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